in the investigations relating to the partial differential equation of Hamilton and Jacobi, where the author deduces Lambert's important theorem concerning the relations between the time of describing an arc of the orbit, the chord of the arc, the bounding radii of the sector, and the major axis. This last-mentioned theorem for the special case of the parabola was first discovered by Euler, a point on which the late Prof. Oppolzer used to insist; the extension of the theorem for any value of the eccentricity of the orbit being due to Lambert. A short historical sketch of the matter contained in this section, referring chiefly to the labours of Lagrange, Hamilton, and Jacobi, concludes this portion of the subject, and we come to the third section of the book.

This last section of the work treats of the theory of general perturbations. Here, of course, Lagrange's theory of the variation of constants plays an important part, and we have that part fully dwelt upon by the author. The development of the disturbing function is given, and here and there a simplification in the symbols might, we think, with advantage be introduced. In the expansion of $(r_1^2 - 2r_1r_2\cos\theta + r_2^2)^{-\frac{s}{2}}$ we have given the simple expression for half the coefficient of $\cos m\theta$ in terms of Gauss's hypergeometric series, viz.—

$$r_1^{-s}\,\frac{s(s+2)(s+4)\ldots(s+2m-2)}{2m\,.\,m!}\,a^m\,\mathrm{F}\left(\frac{s}{2},\frac{s}{2}+m,m+1,a^2\right)$$

The secular and periodic changes in the elements of the orbit receive the usual treatment, the stability of the solar system is discussed, and also the influence upon the results of terms in the higher powers of the eccentricity and inclination.

A few pages are also devoted to a point which writers are accustomed to say never occurs in the solar system—viz. commensurability of the mean motions of two planets. The importance of the subject treated in this section induces the author to extend the limits of the historical sketch with which he has concluded the two previous sections, and to give a little more fully the history of the important theory of perturbations; and he adds, in conclusion, that the best proof of the truth of Newton's law is in the discovery of the cause "of the observed irregularities in the motion of Uranus," a cause suspected by Bouvard and by Bessel, and a problem which death prevented the latter from undertaking, but which was "von zwei anderen Astronomen Leverrier und Adams gelost." Speaking of the latter, the author remarks that "er seine Resultate einige Monate früher dem Astronomen Airy mittheilte"; the want of a "Durchmusterung," however, placed the optical discovery of Neptune in the hands of Dr. Galle.

At the end of the book are given a few small tables chiefly Leverrier's elements of the orbits of the major planets, except for Uranus and Neptune, Newcomb's more correct values of these quantities being adopted.

We note a few misprints. On p. 5, at the bottom, referring to the rotation of the axes, "$+x$ nach $+z$" should obviously read "$+y$ nach $+z$." On p. 11, for k_2 read k^2. On p. 45, in differentiating V, a homogeneous function of degree −1, the factor z of $\frac{dV}{dz}$ is omitted. On p. 46 it might be mentioned that $M = \Sigma m$. In the copy before us, pp. 225 to 240 are omitted, and pp. 273 to 288 have been bound in their place.

Regarding the whole book, we may say that there is much that may be found in any ordinary text-book on the subject. But the author has endeavoured to do more than give a mere sketch, as writers of the present day usually do, leaving the reader to search the pages of *Crelle's Journal*, the *Comptes rendus*, or some similar publication, for important papers connected with the subject. Where these have appeared useful, they have been introduced in a modified form if necessary; and where such papers are interesting, but beyond the scope of the present work, full references are given—a practice much to be commended. The author expresses a hope that he will be able to deal later with the theory of the rotation of bodies about their centres of gravity, the figure of the earth, &c., and with the theory of the tides; and we wish him the success which the present work augurs.

R. B.

NOTES.

DR. ALFRED R. WALLACE has in the press a new work on Darwinism, which aims at establishing the theory of natural selection on a firmer basis, and also deals with the various supplementary theories which have been put forth since the publication of the sixth edition of the "Origin of Species." The book will be published early next year by Messrs. Macmillan and Co.

PROF. GIARD'S first lecture at the Sorbonne is published in the *Revue Scientifique* (December 1). It was delivered before a large audience, and many hundreds of persons had to be content to stay at the door. The Thursday lectures of M. Giard are devoted to an historical sketch of embryology in its relation to the theory of evolution. The Saturday lectures are devoted to embryological phenomena, considered generally.

ON the 19th inst. a monument of the astronomer Leverrier is to be unveiled by the French Minister of Public Instruction, in the Cour d'Honneur of the Paris Observatory. The likeness of Leverrier is said to be very striking. The statue of Arago is finished, and has been sent to the foundry. It will be situated close to the Observatory Gardens, but is not to be put in its place until after the Exhibition.

THE well-known botanist, Dr. C. J. de Maximowicz, writing from St. Petersburg to Kew about Prjevalsky, whose last book we review to-day, says:—"Yes, poor Prjevalsky is dead, and I mourn for him like a brother. He was a splendid character and a highly gifted man. He died with his Expedition fitted out and ready to start. Under these circumstances, the Russian Geographical Society intends to appoint, as head of the Expedition, Colonel Pentsow, a good topographer, who has already twice been in Northern Mongolia. Lieutenant Roborofski, Prjevalsky's associate, and a very capable officer and good collector, who did the botanical work during the two last journeys, is to go also. The plan is to remain the same, perhaps with the exception of Lhassa and the investigation of Northern Tibet. But the Society will appoint this time a geologist, which it is indeed high time to do."

WE learn that the Hon. John Collier has just completed a portrait of Dr. A. W. Williamson, For. Sec. R.S. This portrait, which is to commemorate the thirty-eight years of Dr. Williamson's professorial work at University College, will be presented to the College by Sir Henry Roscoe, on behalf of the subscribers, on Wednesday, December 12, at 4.30 p.m. The subscribers to this portrait will give a dinner to Dr. Williamson on the same evening at the Freemasons' Tavern.

LAST Saturday, a very large meeting, convened by the Council of the Teachers' Guild of Great Britain and Ireland, was held at the rooms of the Society of Arts, Adelphi, to consider a subject which is likely soon to attract much serious attention—the organization of secondary education. The Guild numbers among its Presidents some of the most eminent authorities on higher education, as Heads of Colleges, Professors of the English, Scotch, and Irish Universities, the President of the Royal Academy, Prof. Huxley, and Mr. Mundella. Sir Philip Magnus, who presided, said that at present no public body was responsible for the secondary education of the country. There was no department which was cognizant of the secondary schools, or of the character of the education which they provided. He insisted that it was necessary that some kind of machinery should be brought into existence for several specified objects, including (1) provision of a sufficient number of efficient secondary schools duly related to one another, and to the elementary schools beneath them, and to the Universities above them; (2) the adaptation of the instruction given in these schools to the wants and requirements of different towns and districts; (3) the registration of teachers employed in these schools; (4) the utilization of the present enormous secondary scholarship fund to provide free places in these schools, and to enable pupils from the elementary schools to receive a good secondary education, and, in certain cases, higher technical or University education; (5) the regulation and inspection of all schools in receipt of funds derived from public sources, and the recognition of all private schools that submit to such inspection; (6) the annual publication of reports showing the number and distribution of schools, the curriculum of studies, the qualifications of the teachers, the character of the teaching appliances, and the general and sanitary condition of the schools. The meeting almost unanimously passed a resolution, proposed by Prof. Gladstone, F.R.S., to the effect that an Educational Council should be called into existence, in whose hands the organization of the secondary education of the country should be placed.

THE yearly volume of the *Kew Bulletin* for 1888 is now ready. This most useful publication, as our readers are aware, contains notes on the economic products of plants which have been made the subject of particular study and investigation at Kew, and it serves as a means of communication to persons interested in botanical subjects and products in India and the colonies. In the December number there are papers on Inhambane Copal, the cultivation of rice in Bengal, silkworm thorn, Jamaica india-rubber, seedlings of sugar-cane at Barbadoes, and ramie. In the paper on seedlings of sugar-cane at Barbadoes, attention is called to the fact that Mr. J. B. Harrison, Professor of Chemistry and Agricultural Science at Barbadoes, acting in conjunction with Mr. T. R. Bovell, superintendent of Dodd's Reformatory, has been engaged during the last three years in cultural and chemical experiments with various kinds of sugar-canes. A statement sent by Prof. Harrison appears to prove, in a perfectly natural and circumstantial manner, that a few mature seeds may occasionally be produced by the sugar-cane under certain circumstances. This discovery, if it is fully confirmed, may have an important effect on the practical treatment of the question whether the saccharine qualities of the sugar-cane are capable of being improved on the same lines as those successfully adopted with regard to the beet.

WE are glad to see that a German translation of Miss A. M. Clerke's "Popular History of Astronomy during the Nineteenth Century" has just been issued. A most appreciative review of the work appears in the current number of the *Naturwissenschaftliche Wochenschrift*.

MESSRS. CASSELL AND CO. have begun to issue, in monthly parts, a new edition of their well-known "Popular Educator." This work, we need scarcely say, has been of essential service to many a student who has undertaken in earnest the task of self-education, and in its new form it may be even more useful in the future than it has been in the past. The lessons are being revised throughout, and a large portion of the work will be entirely rewritten. Among the new illustrations is a series of coloured plates, prepared for the benefit of students of ethnology, geology, astronomy, physical geography, botany, &c.

MESSRS. MACMILLAN AND BOWES, Cambridge, announce that the first volume of the "Mathematical Papers," by Prof. Arthur Cayley, will be ready in January 1889.

A LARGE number of new fluorine compounds of the rare metal vanadium have been prepared by Dr. Emil Petersen, of Copenhagen. No fluoride of vanadium has hitherto been obtained, the only compounds previously known containing fluorine and vanadium being the fluoxy-vanadates of Baker, and a few other oxy-compounds, recently described by Piccini and Giorgio, which latter appear to have been independently obtained by Petersen. The most important of the new compounds is sesqui-fluoride of vanadium itself, V_2F_6, which has been obtained in fine large rhombohedrons of a dark-green colour, containing six molecules of water of crystallization, and very soluble in water. Next in importance are two probably isomorphous double fluorides of vanadium with potassium and ammonium, $V_2F_6 . 4KF . 2H_2O$, and $V_2F_6 . 4NH_4F . 2H_2O$; the former was obtained in the form of a bright-green crystalline precipitate, and the latter in brilliant emerald-green and tolerably large octahedra. Besides this compound with ammonium fluoride, another, of the composition $V_2F_6 . 6NH_4F$, was isolated in small grass-green, regular octahedra; this salt is especially interesting as being isomorphous with the analogous chromium and titanium compounds. To complete the isomorphous group, Dr. Petersen has also prepared the aluminium compound $Al_2F_6 . 6NH_4F$. Another interesting pair of isomorphous salts are the compounds $V_2F6 . 2CoF_2 . 14H_2O$ and $V_2F6 . 2NiF_2 . 14H_2O$, the former of which was obtained in dark-green, and the latter in grass-green monoclinic prisms. The remarkable similarity of the sesqui-vanadium and sesqui-chromium compounds is again beautifully shown by the fact that two precisely analogous salts containing cobalt or nickel and chromium instead of vanadium were successfully prepared, containing also fourteen molecules of water of crystallization and crystallizing in green monoclinic prisms. In addition to these important double fluorides of vanadium sesqui-fluoride, a number of oxy-fluorides, derived from vanadic anhydride, V_2O_5, and analogous to the well-known oxychlorides of phosphorus, have also been obtained in combination with alkaline fluorides. The two most important of these appear to be the oxyfluorides, $VOF_3 . 2KF$ and $VO_2F . 2KF$, the latter forming beautiful golden-yellow hexagonal prisms. This preliminary communication of Dr. Petersen, which will be found in the current *Berichte*, just received, forms a rich addition to our information concerning the element vanadium, and the details of the preparation of these well-crystallized salts, a small selection of which only have been described above, will be looked forward to with considerable interest.

THE new Ethnological Museum in Sydney, nominally opened last January, has now really been made accessible to the Australian public. The collection, which includes a large number of weapons and implements obtained from aboriginal races, is described by the *Sydney Daily Telegraph* as one "of absorbing interest."

WE have received Nos. 2 and 3 of vol. lvii. part of the Journal of the Asiatic Society of Bengal. They contain notes on Indian Rhynchota, by E. T. Atkinson; a paper on the tornado which occurred at Dacca on April 7, 1888, by A. Pedler and A. Crombie; notes on the Amphipoda of Indian waters, by C. M. Giles; a paper on *Eupetaurus*, a new form of flying squirrel from Kashmir, by O. Thomas; and notes on Indian Chiroptera, by W. T. Blanford, F.R.S.

MR. THOMAS's account of the new form of flying squirrel from Kashmir, is very interesting. In connection with its dental evolution Mr. Thomas says it would be advisable for naturalists and sportsmen in Kashmir to notice what its food is, as compared with that of other squirrels. Judged from its blunt claws, it probably frequents rocks and precipices rather than trees, and it is therefore possible that its ordinary food may consist of lichens, mosses, and other rock-loving plants, which, by being mixed with sand and particles of rock, would necessitate the development of such long lasting molars as it is remarkable for possessing. Additional specimens of *Eupetaurus* would be most valuable for scientific examination, especially if of different ages; and Mr. Thomas expresses a hope that some of the many British sportsmen who annually visit Kashmir will help to enrich either the Indian Museum in Calcutta, or the National Museum at home, with examples of this, the latest addition to the mammal fauna of our Indian Empire.

IN the new number of the *Zoologist* Mr. T. Southwell has an interesting article on Pallas's sand grouse in Norfolk. Speaking of a large flock which Mr. Wood, of Morston, had under his close observation for some months, Mr. Southwell says that they frequented the same fields with great regularity; their favourite feeding-place being a large clover layer, from which, if disturbed, they flew across to some adjacent turnip-fields, choosing the bare patches for their feeding-ground. Here they spread over a circle of some 30 or 40 yards, separating, and diligently searching the ground until they appeared to have exhausted the food in that particular locality, when they all rose together and repaired to a fresh spot, which they exhausted in like manner. At stated times they departed for the salt marshes adjacent. The bird is usually extremely shy, but not always. Mr. A. Napier was shooting on the Holkham sand-hills with Lord Leicester and party, on October 13, when they met with a flock of about thirty-five. "A single bird," says Mr. Napier, "which I came upon, I felt convinced must have had either a nest or young. When first I saw it, it fluttered along in front of me just like a partridge with young. It was so tame that I called Lord Leicester and the others up to see it, and it did not fly up until we had approached to within 3 or 4 yards of it. At first I thought it must have been a wounded bird, but I do not think so now, for it flew away very strongly, calling out most lustily. Its action reminded me very much of the turtle-dove." Other incidents of a like kind are recorded by Mr. Southwell. On August 5 the gardener at Shernbourne Hall came to Mr. Parsons to say that a sand grouse was running about on the lawn. Mr. Parsons went out to catch it, thinking his son's pinioned bird had escaped. On being approached, the bird "ran and skulked in a little ditch," and did not rise till Mr. Parsons was about to put his hand on it, when it flew away "quite strong." Another, now in Mr. Gurney's aviary at Northrepps, was found, on October 31, floundering in a wet ditch at Suffield, and taken by hand.

WE learn from the *Canadian Record of Science* (vol. iii. No. 3) that in June 1887 a small collection of graptolites was obtained by Dr. G. M. Dawson, on Dease River, in the extreme northern and inland portion of British Columbia, about lat. 59° 45′, long. 129°. These fossils were derived from certain dark-coloured, carbonaceous and often calcareous shales, which, in association with quartzites and other rocks, characterize a considerable area of the lower part of the Dease, as well as the Liard River, above the confluence. In 1886 a similar small collection was obtained by Mr. G. R. McConnell, near the line of the Canadian Pacific Railway, in the Kicking Horse (Wapta) Pass. No other locality in the western portion of the Dominion has yet been found to yield graptolites. Prof. Lapworth, to whom Dr. Dawson's collection has been transmitted, thinks that the graptolite-bearing rocks are clearly of about Middle Ordovician age. They contain forms he would refer to the second or Black River Trenton period; *i.e.* they are newer than the Point Lévis series, and older than the Hudson and Utica groups. The association of forms, he says, is such as we find in Britain and Western Europe, in the passage beds between the Llandeilo and Caradoc Limestones.

THE following are the lecture arrangements of the Royal Institution before Easter:—Prof. Dewar, six lectures (adapted to a juvenile auditory) on clouds and cloudland; Prof. G. J. Romanes, twelve lectures constituting the second part of a course on before and after Darwin (the evidences of organic evolution and the theory of natural selection); Prof. J. W. Judd, four lectures on the metamorphoses of minerals; Dr. Sidney Martin, four lectures on the poisonous action of albuminoid bodies, including those formed in digestion; Prof. J. H. Middleton, four lectures on houses and their decoration from the classical to the mediæval period; Prof. Ernst Pauer, four lectures on the characters of the great composers and the characteristics of their works (with illustrations on the pianoforte); and eight lectures by the Right Hon. Lord Rayleigh, on experimental optics (polarization; the wave theory). The Friday evening meetings will begin on January 25, when a discourse will be given by Prof. G. H. Darwin; succeeding discourses will probably be given by Prof. W. C. McIntosh, Sir William Thomson, Prof. A. W. Rücker, Mr. Harold Crichton Browne, Prof. Oliver Lodge, Prof. Archibald Geikie, the Rev. Alfred Ainger, the Right Hon. Lord Rayleigh, and other gentlemen.

THE Russian naturalist, M. K. Nossilów, has been making geological investigations in Nova Zembla, and has discovered traces of gold.

PROF. OLIVER J. LODGE writes to us as follows about his letter on the "Velocity of Sound" (NATURE, November 22, p. 79): "In equation (6), $U + v$ should, strictly, be $-U + v$, because the sign of U has changed with its signification. Equation (7) is therefore wrong. In the paragraph between equations (3) and (4), the words 'condensation' and 'rarefaction' should be transposed."

THE additions to the Zoological Society's Gardens during the past week include two Squirrel Monkeys (*Chrysothrix sciurea*) from Guiana, presented by Master H. B. Young; a Silvery Gibbon (*Hylobates leuciscus* ♂) from Burmah, presented by Captain D. L. de la Chevois; a Pig-tailed Monkey (*Macacus nemestrinus* ♀) from Java, presented by Mr. W. Merryweather; a Polecat (*Mustela putorius*), British, presented by Mr. F. D. Lea Smith, F.Z.S.; a Raven (*Corvus corax*), British, presented by Mr. C. Petrzywalski; a Sparrow Hawk (*Accipiter nisus*), British, presented by Mr. G. Skegg; two Barn Owls (*Strix flammea*), British, presented by Mr. E. Hart, F.Z.S.; a Lion Marmoset (*Hapale rosalia*) from Brazil, deposited; a Blue-cheeked Barbet (*Megalæma asiatica*) from India, a Golden-crowned Conure (*Conurus aureus*) from South-East Brazil, a Golden-winged Parrakeet (*Brotogerys chrysopterus*) from the Amazons, purchased.

OUR ASTRONOMICAL COLUMN.

STONYHURST COLLEGE OBSERVATORY.—The Report of this Observatory for 1887, which has been recently published, is of the usual character, giving the results of the magnetic and meteorological observations for the year. The daily areas of the spots observed upon the sun during 1886 and 1887, expressed in millionths of the sun's visible hemisphere, are also given in both tabular and graphical form. The latter shows in a very striking manner the remarkable depression in spot-activity which marked the seven months from the end of September 1886 to the end of April 1887, and the regular series of gentle undulations which succeeded it. A note on the "Upper Glows in 1887" records that the white haze round the sun, and the pink "fore" and "after" glows consequent upon the Krakatão explosion, were still observed occasionally in 1887, but more feebly and less frequently than in 1886.

THE HOPKINS OBSERVATORY.—The little Observatory of this name attached to Williams College, Mass., is the oldest public Observatory in the United States, and during the past summer the jubilee of its dedication was duly celebrated. This interesting commemoration was made the occasion for the delivery of a discourse by Prof. T. H. Safford, Field Memorial Professor of Astronomy at Williams College, on the development of astro-